Research Paper

Comparison of Response policy to COVID-19: focus on prediction model

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Dohyo Jeong
University of Texas at Dallas

Contents

Introduction

Frameworks

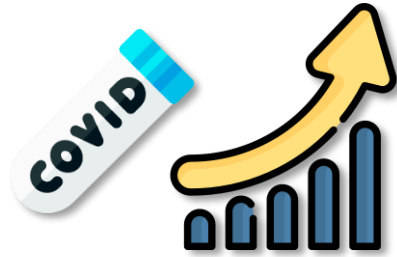Data and Variables

Resluts

Introduction

Governance Response Policy
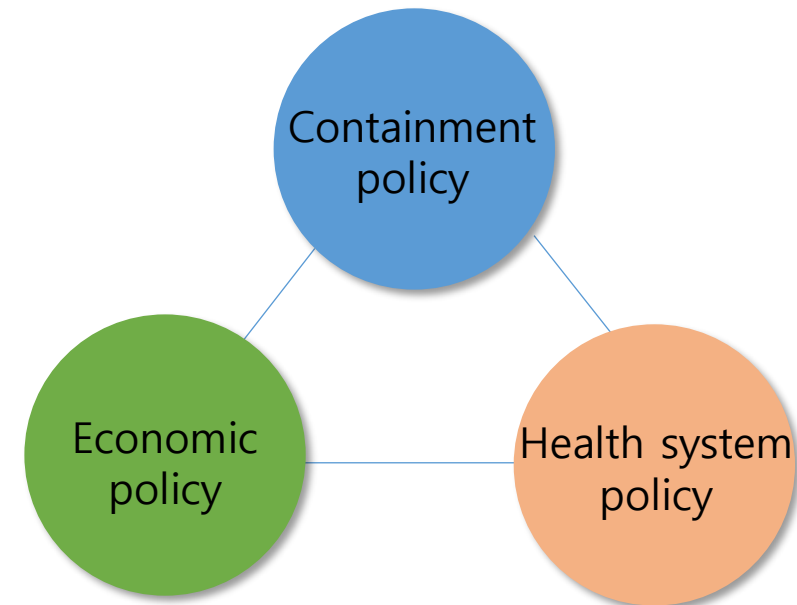
The government implements various policies to prevent the spread of infectious diseases.

The circumstances of each government determine the characteristics and intensity of each policy.

Containment policy

Economic policy

Health system policy

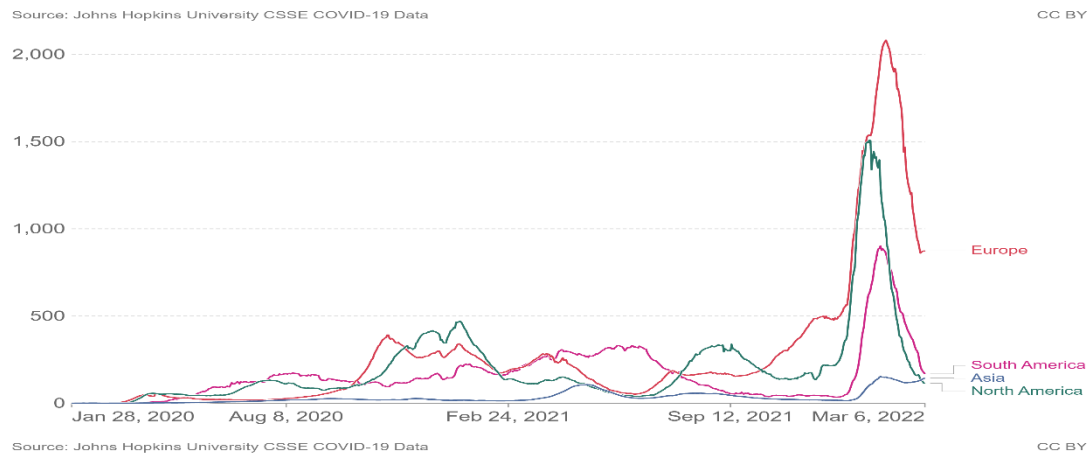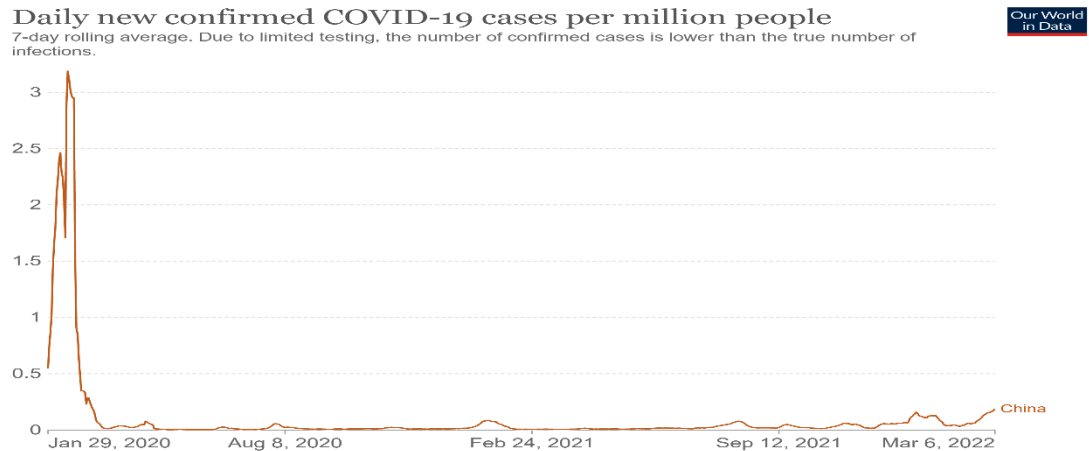Oxford governance COVID-19 response index

Research Question

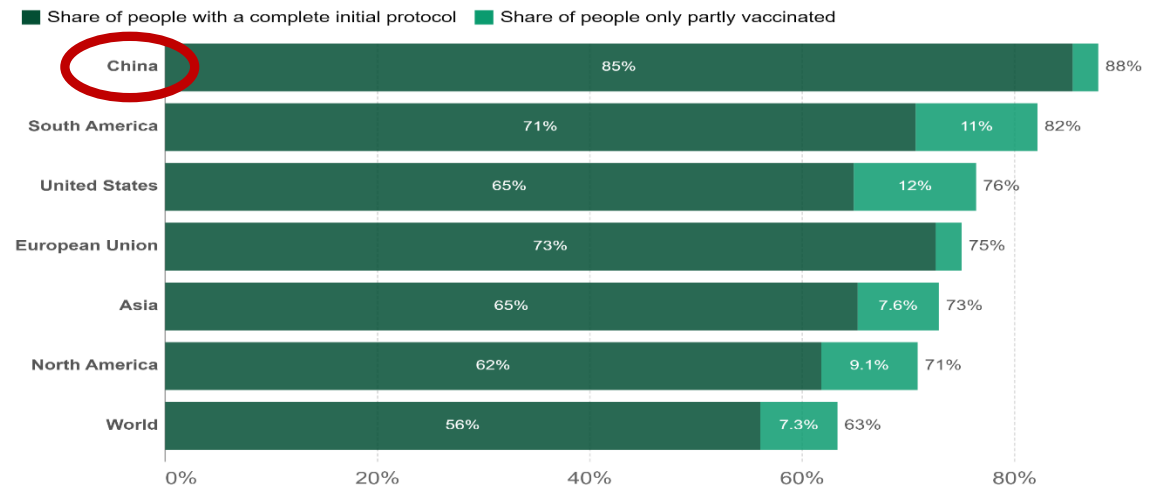**Q1: What response policies were important in each countries?**

Introduction

China has significantly different patterns on COVID pandemic

Daily new confirmed COVID-19 cases per million people
7-day rolling average. Due to limited testing, the number of confirmed cases is lower than the true number of infections.

Our World in Data

Source: Johns Hopkins University CSSE COVID-19 Data

CC BY

Source: Johns Hopkins University CSSE COVID-19 Data

CC BY

Share of people vaccinated against COVID-19, Mar 6, 2022

Our World in Data

■ Share of people with a complete initial protocol   ■ Share of people only partly vaccinated

Region	Complete initial protocol	Only partly vaccinated	Total
China	85%		88%
South America	71%	11%	82%
United States	65%	12%	76%
European Union	73%		75%
Asia	65%	7.6%	73%
North America	62%	9.1%	71%
World	56%	7.3%	63%

Source: Official data collated by Our World in Data
Note: Alternative definitions of a full vaccination, e.g. having been infected with SARS-CoV-2 and having 1 dose of a 2-dose protocol, are ignored to maximize comparability between countries.

CC BY

Research Question

Q2: Is China's response policy different from other countries?

Research Design

Data: OxCGRT, a government response index

- Unit of Analysis: Government

- From January 2020 to March 2022
- 831 days

Variables

▶ **Dependent Variable**
- Degree of change in confirmed cases

▶ **Input Variable**
- 16 response policies

Methodology

▶ **Predict model**
- Regression Decision Tree and Random Forest

▶ **Vector autoregression (VAR)**
- Granger causality test

Table 1. Variable

System	Policies
Containment policies	stringency
	school closing
	work closing
	event closing
	restriction gatherings
	transport closing
	stay home
	restriction move
	restriction travel
Economic policies	income support
	debt relief
Health system policies	public campaigns
	testing policy
	contact tracing
	mask policy
	vaccine policy
	elder protect

Oxford governance COVID-19 response index

Descriptive analysis

Descriptive statistical analysis result

|		China		Korea		US	
	Obs	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.
Containment policy — stringency	831	69.60	13.85	49.67	13.48	56.93	17.88
school closing	831	2.51	0.80	1.65	1.05	2.23	0.82
work closing	831	2.43	0.71	1.52	0.64	1.78	0.78
event closing	831	1.92	0.35	1.59	0.56	1.62	0.62
restriction gatherings	831	3.83	0.70	3.40	1.27	3.39	1.17
transport closing	831	1.11	0.90	1.11	0.90	0.91	0.29
stay home	831	2.37	0.99	0.58	0.56	1.21	0.59
restriction move	831	1.80	0.49	0.69	0.71	1.49	0.65
restriction travel	831	2.45	0.80	2.41	0.70	3.03	0.75
Economic policy — income support	831	0.88	0.33	0.89	0.31	1.13	0.92
debt relief	831	1.47	0.77	0.91	0.29	0.67	0.47
Health system policy — public campaigns	831	1.98	0.18	1.93	0.38	1.82	0.57
testing policy	831	2.84	0.50	2.45	0.93	2.77	0.78
contact tracing	831	2.00	0.07	1.92	0.38	0.98	0.15
mask policy	831	2.39	0.79	2.41	0.96	2.96	1.09
vaccine policy	831	2.34	2.29	2.08	2.22	2.36	2.33
elder protect	831	2.14	0.82	1.96	0.69	1.98	0.57

- China has the most stringent policies

- China most actively uses containment policy

- The US mainly used mask and vaccine policy
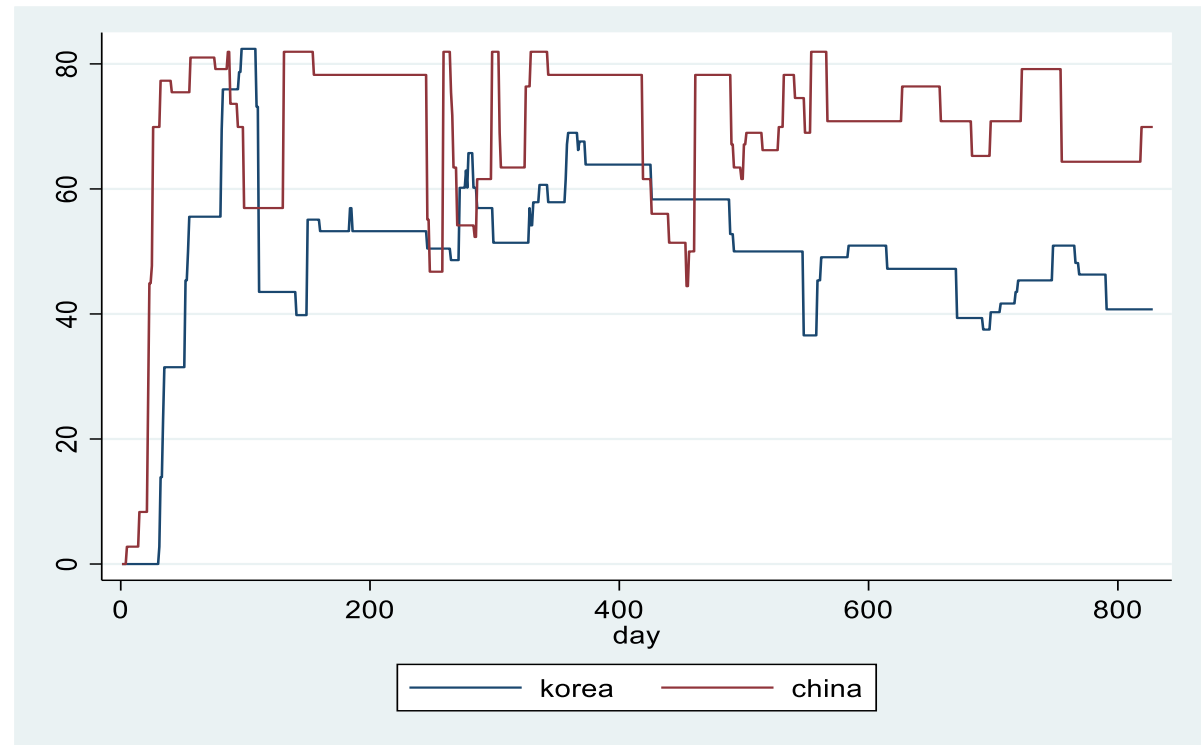
Descriptive analysis

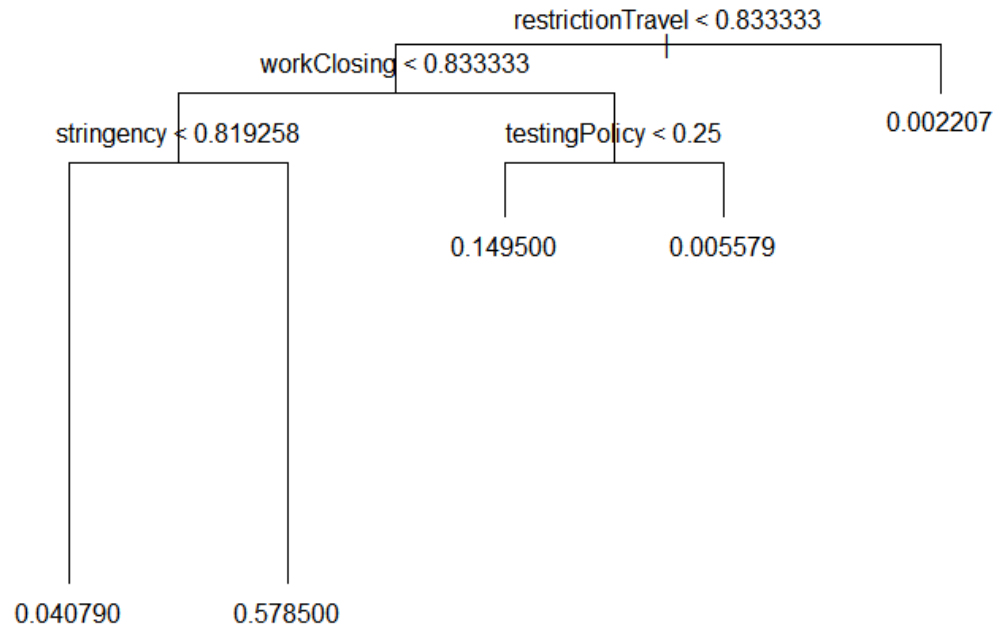Stringency Index Trend Comparison

China vs. US
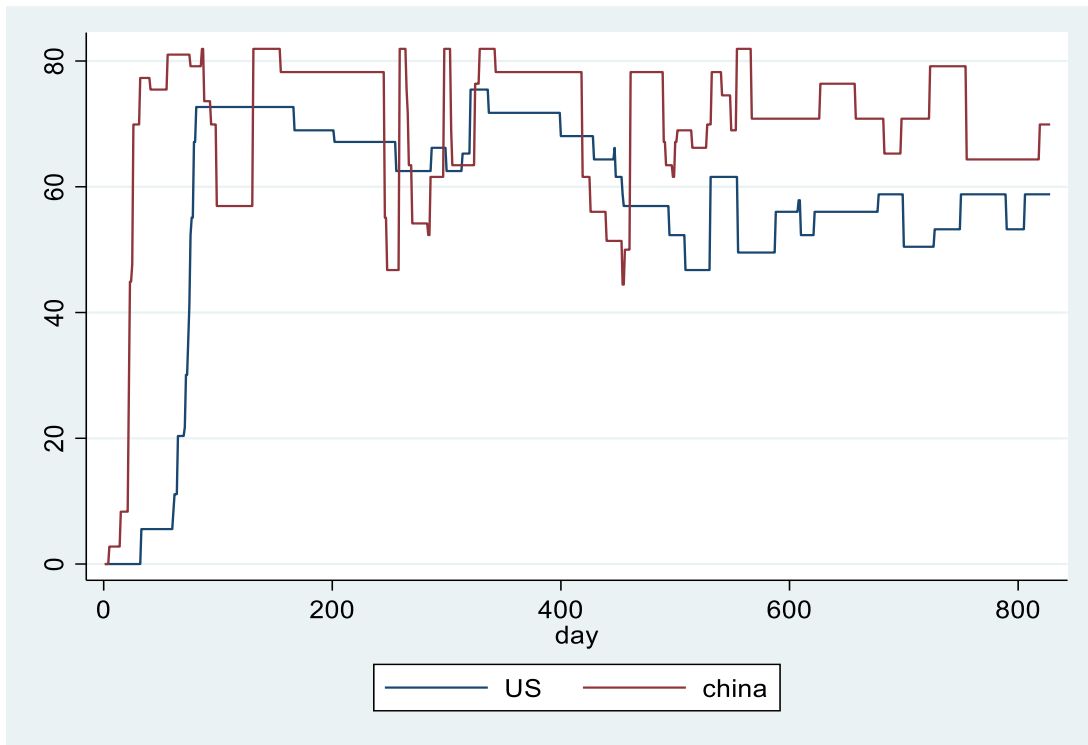
China vs. Korea

Response Policy in China

Regression Decision Tree

MSE: 0.002183

China Regression Tree
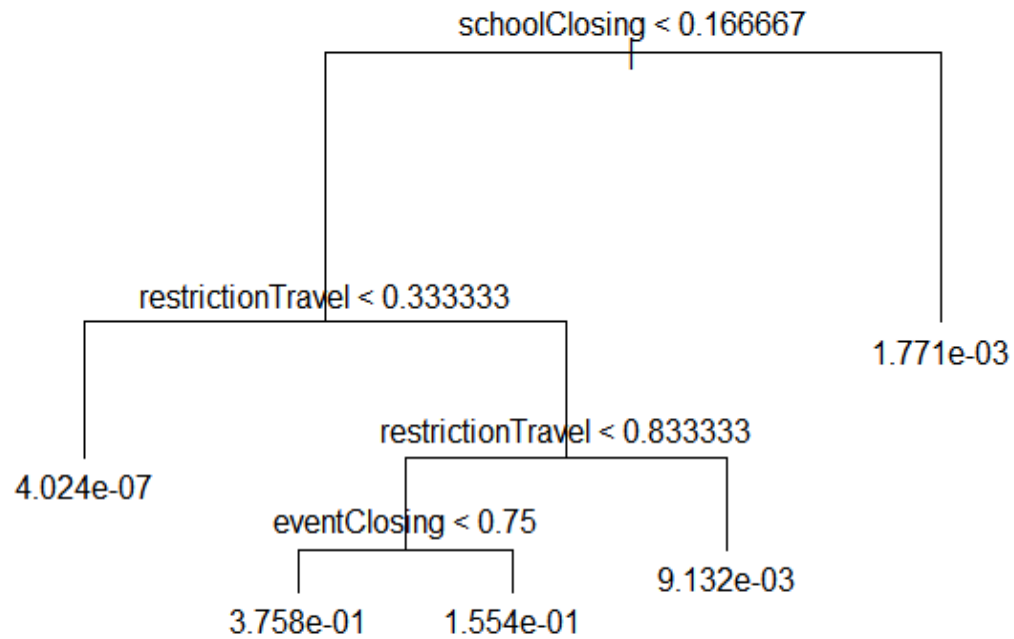

Random Forest

MSE: 0.00211

China_Response_Policy

Page 3

Response Policy in Korea
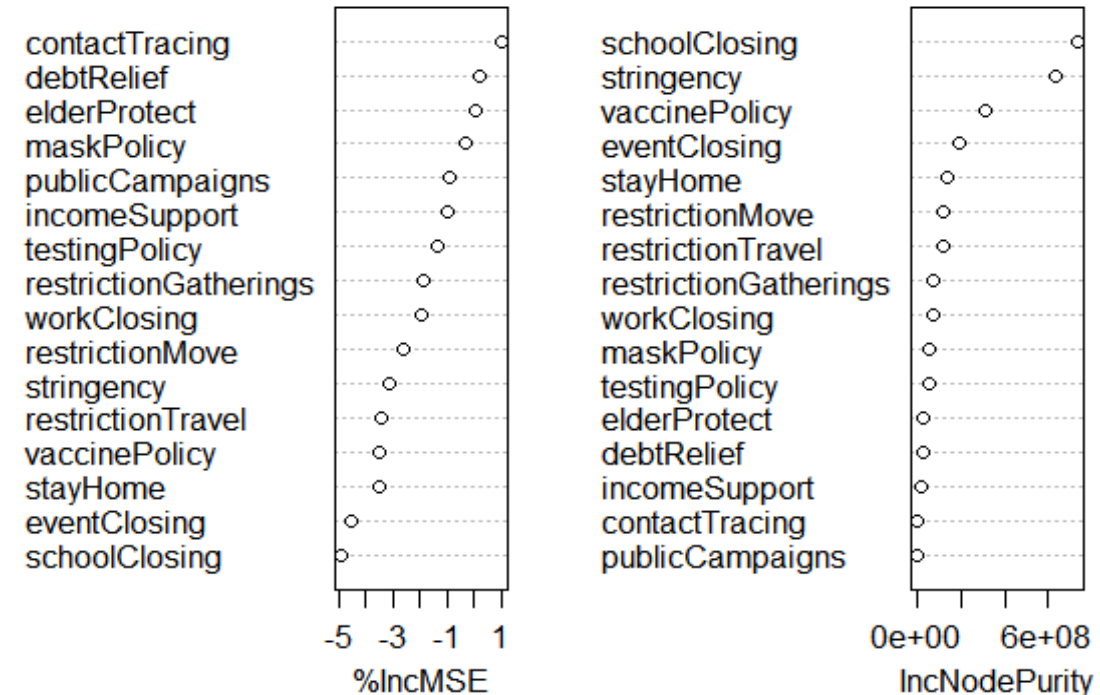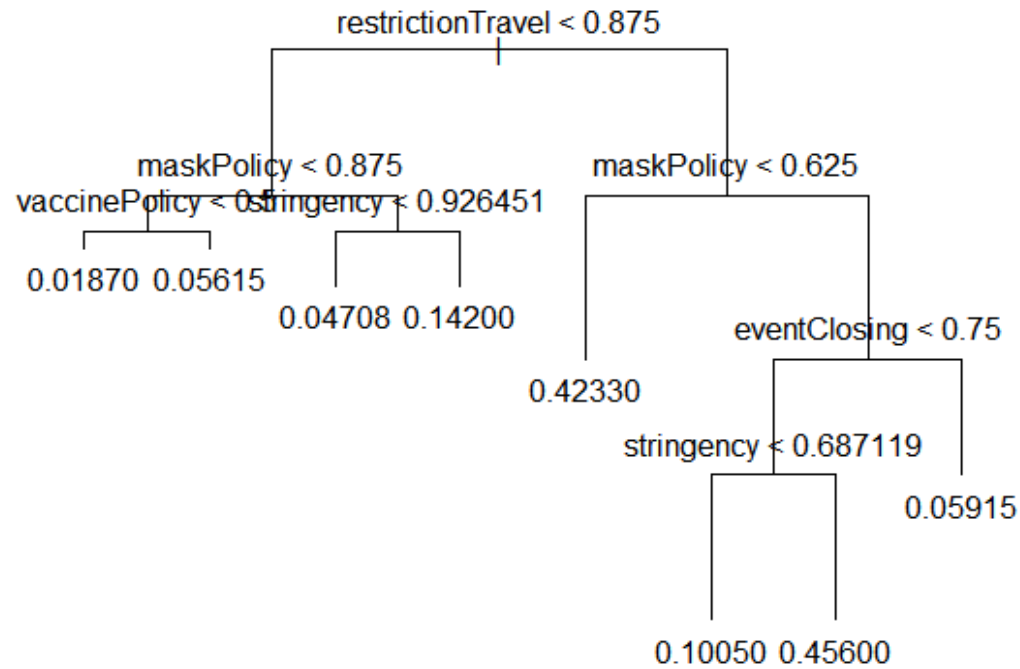
Regression Decision Tree

MSE: 0.002496

Korea Regression Tree

schoolClosing < 0.166667

restrictionTravel < 0.333333

1.771e-03

4.024e-07

restrictionTravel < 0.833333

eventClosing < 0.75

9.132e-03

3.758e-01   1.554e-01

Random Forest

MSE: 0.001557

Korea_Response_Policy

contactTracing
debtRelief
elderProtect
maskPolicy
publicCampaigns
incomeSupport
testingPolicy
restrictionGatherings
workClosing
restrictionMove
stringency
restrictionTravel
vaccinePolicy
stayHome
eventClosing
schoolClosing

-5 -3 -1 1
%IncMSE

schoolClosing
stringency
vaccinePolicy
eventClosing
stayHome
restrictionMove
restrictionTravel
restrictionGatherings
workClosing
maskPolicy
testingPolicy
elderProtect
debtRelief
incomeSupport
contactTracing
publicCampaigns

0e+00   6e+08
IncNodePurity

Page 3

COVID-19 response

Response Policy in US

Regression Decision Tree

MSE: 0.00215

US Regression Tree

restrictionTravel < 0.875

maskPolicy < 0.875

vaccinePolicy < 0 stringency < 0.926451

0.01870 0.05615

0.04708 0.14200

maskPolicy < 0.625

0.42330

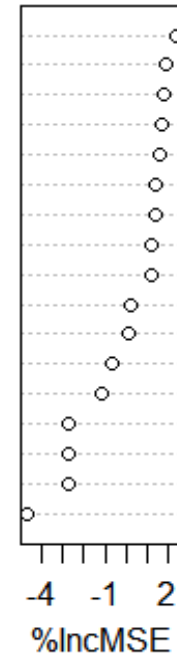eventClosing < 0.75

stringency < 0.687119

0.05915

0.10050 0.45600

Random Forest

MSE: 0.001762

US_Response_Policy

workClosing
publicCampaigns
trasnportClosing
eventClosing
testingPolicy
stringency
maskPolicy
stayHome
restrictionGatherings
restrictionMove
contactTracing
vaccinePolicy
elderProtect
incomeSupport
schoolClosing
debtRelief
restrictionTravel

-4 -1 2
%IncMSE

maskPolicy
stringency
restrictionTravel
eventClosing
vaccinePolicy
restrictionMove
elderProtect
restrictionGatherings
incomeSupport
debtRelief
schoolClosing
workClosing
trasnportClosing
stayHome
testingPolicy
publicCampaigns
contactTracing

0.000 0.008
IncNodePurity

Page 3
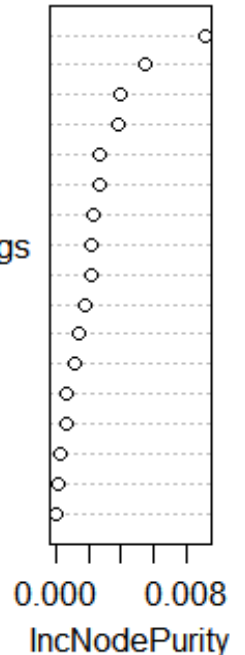
Granger causality test for China

China's confirmed cases trend line
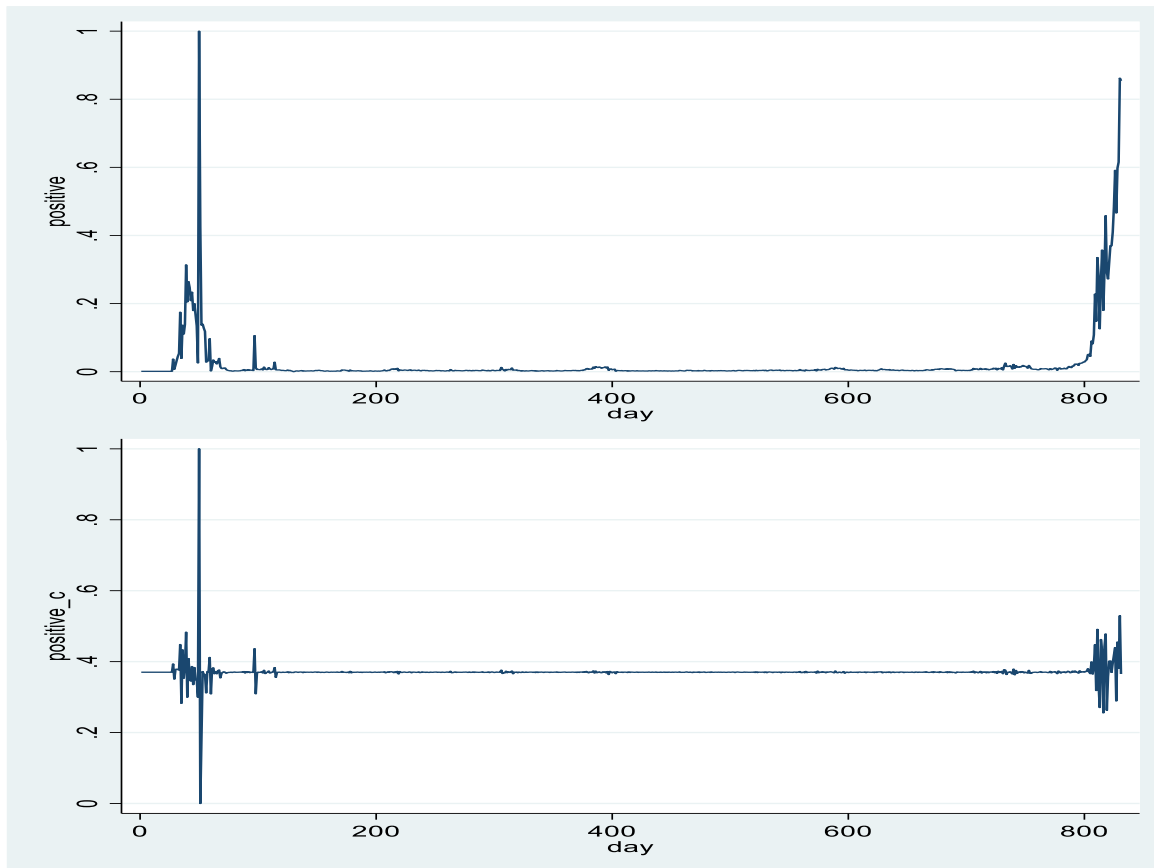
Dickey-Fuller test

Variable	z(t)
positive	-5.403***
work closing	-4.630***
restriction gatherings	-6.145***
elder protect	-3.107***
testing policy	-3.829***
stringency	-5.209***
stay home	-4.794***
Observation	830
*** $p < 0.001$	

- The optimal time lag was analyzed as seven days

Page 3

Granger causality test for China

Granger causality Wald tests

Equation	Excluded	chi2	P > chi2
positive	work closing	6.5557	0.010 ***
	restriction gatherings	0.8464	0.358
	elder protect	17.049	0.000 ***
	testing policy	18.165	0.000 ***
	stringency	3.4092	0.065
	stay home	4.0558	0.044 **
	ALL	35.077	0.000 ***
** p < 0.05, *** p < 0.01			

eigenvalues test

Roots of the companion matrix

- Also, the change in confirmed cases had the Granger causality between stay home and testing policy.
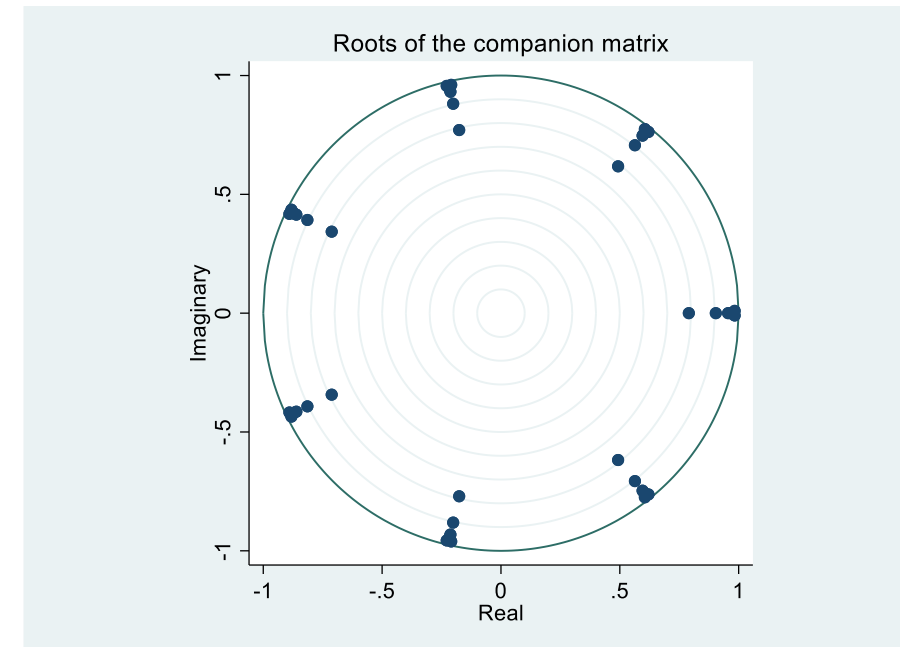
- All eigenvalues are within the unit circle.
- VAR performed satisfies the stability condition.

Implications

▶ This study created a **predictive model for the effective response policies** for each country.

- China's containment policy plays an important role compared to other countries

- Korea: school closures and contact tracking

- US: mixes various policies

▶ Based on this model, we can predict the effective policies for each country when a new disease occurs.

▶ Also, in the case of China, a **time-series influence** was confirmed.

limitations

▶ Regression decision trees and random forests **do not reflect time-series characteristics**.

- Therefore, I will utilize **Long Short-Term Memory (LSTM)** that can reflect time series characteristics as a next step.

COVID-19 response 🔍

Thank you!

Reference

Balmford, B., Annan, J. D., Hargreaves, J. C., Altoè, M., & Bateman, I. J. (2020). Cross-country comparisons of Covid-19: policy, politics and the price of life. Environmental and Resource Economics, 76(4), 525-551.

Bastos, S. B., & Cajueiro, D. O. (2020). Modeling and forecasting the early evolution of the Covid-19 pandemic in Brazil. Scientific Reports, 10(1), 1-10.

Brauner, J. M., Mindermann, S., Sharma, M., Johnston, D., Salvatier, J., Gavenčiak, T., ... & Kulveit, J. (2021). Inferring the effectiveness of government interventions against COVID-19. Science, 371(6531), eabd9338.

Carraro, A., Ferrone, L., & Squarcina, M. (2020). Are COVID-19 containment measures equally effective in different world regions?. DISEI, Università degli Studi di Firenze.

Cross, M., Ng, S. K., & Scuffham, P. (2020). Trading health for wealth: The effect of COVID-19 response stringency. International Journal of Environmental Research and Public Health, 17(23), 8725.

Hawkins, R. B., Charles, E. J., & Mehaffey, J. H. (2020). Socio-economic status and COVID-19–related cases and fatalities. Public health, 189, 129-134.

James, G., Witten, D., Hastie, T., & Tibshirani, R. (2013). An introduction to statistical learning (Vol. 112, p. 18). New York: springer.

Kaçak, H., & Yildiz, M. S. (2020). Stringency of government responses to COVID-19 and initial results: A comparison between five European countries and Turkey. Türk Hijyen ve Deneysel Biyoloji Dergisi, 77(2), 233-242.

Migone, A. R. (2020). The influence of national policy characteristics on COVID-19 containment policies: a comparative analysis. Policy Design and Practice, 3(3), 259-276.

Ren, X. (2020). Pandemic and lockdown: a territorial approach to COVID-19 in China, Italy and the United States. Eurasian Geography and Economics, 61(4-5), 423-434.

Reuters. Emma Farge. (2020. 6. 28). WHO says COVID-19 pandemic is 'one big wave', not seasonal. URL: https://www.reuters.com/article/us-health-coronavirus-who-idUSKCN24T16U

Thu, T. P. B., Ngoc, P. N. H., & Hai, N. M. (2020). Effect of the social distancing measures on the spread of COVID-19 in 10 highly infected countries. Science of the Total Environment, 742, 140430.